SEX AND AGE CLASSIFICATION SURVEYS OF PEARY CARIBOU ON BANKS ISLAND, 1982-1998: A REVIEW

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SEX AND AGE CLASSIFICATION SURVEYS OF PEARY CARIBOU ON BANKS ISLAND, 1982-1998: A REVIEW

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ABSTRACT

Sex and age classification surveys of Peary caribou on Banks Island were conducted sporadically between 1982 and 1991. Since then surveys have been conducted annually. Surveys were partitioned into 5 different circannual periods of Banks Island caribou. Between 1982 and 1998 Peary caribou were classified for 7 calving (May and June), 7 summer (July and August), 7 winter (11 November through March), 6 fall/rut (September through 10 November), and 4 pre-calving (April) periods. We calculated the ratios of calves and yearlings per 100 adult (≥2 year-old) females, and the percentages of calves and yearlings in the survey sample, for each of the 31 surveys. There were significant ($P<0.05$) year effects on calf per 100 adult female ratios. Multiple comparison tests indicated that in 1995 and 1996 ratios were significantly higher than in 1993 and 1994. We determined estimates of calf production for 10 years, range 23.3 (1994) to 75.6 (1982) calves per 100 adult females. In 7 of the 10 years production was >50.0 calves per 100 adult females. We determined overwinter survival of calves by dividing the best estimate of calf production in a given year by the best estimate of the number of yearlings recorded per 100 adult females in the following year. Overwinter survival of calves was determined for 6 years, range 23 (1991-92) to 86% (1993-94). In 4 of the 6 years overwinter survival of calves was >50%. The decline in numbers of non-calf caribou from 709 in 1994 to 425 in 1998 has occurred in the face of high production and overwinter survival of calves.

TABLE OF CONTENTS

ABSTRACT ii

LIST OF FIGURES iv

LIST OF TABLES v

INTRODUCTION 1

METHODS 3

RESULTS 8

DISCUSSION 10

RECOMMENDATIONS 16

ACKNOWLEDGEMENTS 18

PERSONAL COMMUNICATIONS 19

LITERATURE CITED 20

APPENDIX 30

LIST OF FIGURES

Figure 1. Traditional critical Peary caribou wintering, summering, and fall ranges (based upon Urquhart, 1973).

Figure 2. The ratios of calves per 100 adult females from all classification surveys during the different circannual periods from 1982 to 1998 on Banks Island.

LIST OF TABLES

Table 1. The dates of classification surveys, number of animals classified, and method of classification for surveys conducted prior to summer 1993. The values in parentheses represent the number of unclassified adults.

Table 2. The median ratios of the number of calves per 100 adult females in the survey sample for all 10 years when surveys were conducted on Banks Island. n = the number of life cycle periods in which classification surveys were conducted in that year, out of a possible 5. N = the total number of animals classified.

Table 3. Classification data that were used to best estimate the overwinter survival (%) of Peary caribou calves on Banks Island from 1991 to 1998: the survey month(s) classification data were collected, the actual number of calves, yearlings (yrlngs) and 2+ year-old females classified and their accompanying ratios/100 2+ year-old females, and the best estimate of overwinter survival.

Table 4. Comparative ratios of calves per 100 adult females determined from summer (July and August) classification surveys of Peary caribou and Svalbard reindeer.

Table 5. Comparative percent calves determined from summer (July and August) classification surveys in populations of Peary caribou and Svalbard reindeer.

INTRODUCTION

Between 1982 and 1998 Peary caribou (*Rangifer tarandus pearyi*) numbers on Banks Island decreased from *ca.* 7,000 to *ca.* 425 non-calves (Nagy *et al.*, 1996; Nagy and Forsythe, 1996; J. Nagy and M. Branigan, unpubl. data). Population surveys were conducted during summer after calving, therefore non-calves are defined as all animals that are not young of the year (i.e. animals > 12 months-old). Unfortunately, sex and age classification surveys (composition surveys) to monitor calf production and recruitment were conducted sporadically between 1982 and 1991, and were often conducted opportunistically with other ground-based field operations during months with snow cover when travel was easiest. By 1991 the majority of the decline in caribou numbers appeared to have occurred. The caribou population was estimated at *ca.* 900 non-calves in 1991 (Nagy *et al.*, 1996), and an annual quota of 30 caribou, male only, was implemented for the community of Sachs Harbour. In response to local concerns about low caribou numbers, aerial classification surveys to assess calf production and recruitment were initiated in summer 1992 and another population survey was conducted. The 1992 population survey estimated *ca.* 1,005 non-calves (Nagy *et al.*, 1996). The annual quota was re-evaluated at the request of the Sachs Harbour Hunters and Trappers Committee and increased to 36 caribou, male only, where it currently remains. This allowed for one caribou per household. During summer 1993 a large scale range study was initiated which integrated the annual summer aerial classifications surveys of caribou with ground-based classification surveys of caribou. Ground-based surveys were from 6-21 days in length and conducted 6 times during the year, June, July, August, November, February, and April. The range study ran from June 1993 to July 1998 and provided caribou classification data in addition to the annual July aerial classification survey. This report compiles, reviews, and assesses all data from sex and age

classification surveys of Peary caribou conducted on Banks Island from 1982-1998. We present the best estimates of yearly Peary caribou calf production for the Banks Island population, and where adequate data are available we present the best estimates of overwinter survival of calves. We compare our findings with what similar data are available from studies of Peary caribou populations and Svalbard reindeer.

METHODS

Types of Classification Surveys

Five different ground-based classification surveys were conducted from November 1982 to November 1991 (Table 1). One to 4-day round trips were conducted by Department of Resources, Wildlife & Economic Development (DREWD) personnel and local guides on snowmachines from Sachs Harbour into the traditional wintering grounds (Fig. 1). When caribou were located, observers positioned themselves so that caribou could be observed either with binoculars (7x24) or a spotting scope (15-45x). Caribou were classified into calves, yearlings, 2 year-old and older females (adults), and 2 year-old and older males (adults). Whenever possible yearlings and calves were classified as male or female following Bergerud (1961).

In June and August, 1992 and May and June, 1993 classification surveys were flown with a Bell 206B helicopter. Caribou were spotted from the air and the survey crew, generally an observer and a recorder, was positioned by the helicopter. To minimize disturbance and get the best view of animals possible, the helicopter landed 0.5-1.5 km downwind and preferably behind a ridge or hill so as not to be within the animals' direct line of sight. The survey crew then walked to a position where the animals could be classified into the 4 previously described sex and age categories with a spotting scope. In all but the June 1992 survey, an initial reconnaissance flight, of 4 to 8h by fixed-wing aircraft, had located concentrations of caribou prior to the survey.

In June 1993 we began a range study on Banks Island. Field camps were established in the and adjacent to the wintering grounds (Fig. 1). As part of the range study, field trips of 6-21 days in length

were conducted 6 times a year: mid-June, mid-July, mid-August, early November, mid-February, and late-April. The June and July field trips were conducted with the assistance of a Bell 206B or 206L helicopter. The August field trip was conducted with the assistance of 4x4 ATV's, and the November, February, and April field trips were conducted with the assistance of snowmachines. We tried to classify all caribou observed into our 4 sex and age categories during travel associated with these and other field trips. During the July field trip we relocated the helicopter from the southern field camps to a field camp in the north by Nangmagvik Lake (74° 6'N x 120° 0'W). This camp is adjacent to the summering grounds of Banks Island Peary caribou in the northwest corner of the island (Fig. 1). A 3-6 h spaghetti transect flight was conducted with the helicopter over the summering grounds. When caribou were spotted from the air the survey crew, generally an observer and a recorder, was positioned by the helicopter. The survey crew attempted to classify all caribou as described previously into our 4 sex and age categories. In 1994 and 1998, aerial reconnaissance by fixed-wing aircraft involved in the Banks Island population survey had identified areas of local caribou concentration in the summering grounds prior to the classification survey. Therefore, spaghetti transect flights in 1994 and 1998 were generally of shorter duration. Additional classification data were provided by local hunters. During the 32 field trips conducted in association with the 1993-1998 range study 1159 caribou were classified.

Partitioning Classification Data

Because the range study work provided classification data during 6 different months and the previous classification surveys had been conducted in various months, we partitioned the survey data into distinct periods associated with the annual cycle of Banks Island caribou (following the Porcupine Caribou

Technical Committee, 1993). We defined 5 circannual periods (following Urquhart, 1973; R. Kuptana, pers. comm.; A. Carpenter, pers. comm; J. Lucas, pers. comm.) calving (May and June), summer (July and August), fall/rut (September through 10 November), winter (11 November through March), and pre-calving (April). Since 1982, surveys were conducted during similar time periods: i) calving 11-21 June and once 18-20 May, ii) summer 12-31 July and 13-27 August, iii) fall/rut 6-21 September, 9-30 October, and 2-9 November, iv) winter 13 November-12 December, 6-26 February, and 6-30 March, and v) pre-calving 6-30 April.

For each circannual period from each year we calculated the following: i) the ratio of calves per 100 adult females, ii) the ratio of yearlings per 100 adult females, iii) the percentage of calves in the total classified, and iv) the percentage of yearlings in the total classified. Because of generally small sample sizes, all groups, even those with unclassified adults, were included in the calculations. When unclassified adults were included, we calculated the maximum range of the ratios by determining the ratio when all unclassified adults were treated as males, and conversely when all unclassified adults were treated as females. Statistical analyses of the ratios used the mid-range value.

Statistical Analyses

We used a Kruskal-Wallis test on: i) calves:100 adult females, ii) yearlings:100 adult females, iii) the percent calves of classified animals, and iv) percent yearlings of classified animals to determine if there were any significant ($p<0.05$) year or circannual period effects on any of these categories. When Kruskal-Wallis tests indicated significant ($P<0.05$) results, multiple comparisons (Gibbons, 1985) were conducted on the mean class ranks to identify significantly different subsets of years. We used an overall significance

level of 0.25 for multiple comparisons.

Best Estimates of Calf Production

We discarded all circannual classification data where fewer than 20 caribou were classified. From the remaining data we determined our best estimate of calf production as the number of calves per 100 adult females determined from the survey(s) conducted in July and August of the year. Where survey data were unavailable during July and August we used data from surveys conducted as soon after August as possible. We realize that these estimates do not address neonatal mortality and those estimates derived from November data may underestimate productivity more than those derived from only July data, but these were the best data available. The survey data used to best estimate for calf productivity for those years follows: i) 1982 - November 1982, ii) 1990 - October 1990, iii) 1991 - September and November 1991, iv) 1992 - August 1992, v) 1993 October and November 1993, vi) 1994 - July and August 1994, vii) 1995 - July and August 1995, viii) 1996 - July 1996, ix) 1997 - July and August 1997, and x) 1998 - July 1998. For 1996 and 1998 there were no August survey data available.

Best Estimates of Overwinter Survival

We discarded all circannual classification data where fewer than 20 caribou were classified. The best estimate of calf overwinter survival was determined by dividing the best estimate of calf production in a given year by the best estimate of the number of yearlings recorded per 100 adult females in the following year. The best estimates of the number of yearlings per 100 adult females were those data available from May - July, when classification of yearlings is easiest. The survey data used to best estimate

the number of yearlings per 100 adult females follows: i) 1992 - June 1992, ii) 1993 - May and June 1993, iii) 1994 - July 1994, iv) 1996 - July 1996, v) 1997 - July 1997, and vi) 1998 - July 1998.

RESULTS

Classification Data

Between 1982 and 1998 Peary caribou were classified for 7 calving, summer, and winter periods, 6 fall/rut periods, and 4 pre-calving periods (Appendix 1). There were significant ($P<0.05$) year effects on the ratios of calves per 100 adult females. The ratios of calves per 100 adult females was similar in 1995 and 1996 and significantly higher than those ratios of calves per 100 adult females found in 1993 and 1994. The ratios in 1993 and 1994 were similar. All other paired comparisons of the ratios of calves per 100 adult females were not significant (Figure 2). Median values for the ratio of calves per 100 adult females lumped across circannual periods ranged from 22.0 in 1994 to 72.3 in 1982 (Table 2, Appendix 1). There were no significant ($P>0.05$) year or circannual effects on percent calves, yearlings per 100 adult females, or percent yearlings.

Calf Production

We were able to estimate calf production for 10 years (Table 3). Calf production ranged from a high in 1982 of 75.6 to a low in 1994 of 23.3 calves per 100 adult females. In 7 of the 10 years production was >50.0 calves per 100 adult females. Those exceptional years of low calf production were 1993, 1994, and 1996.

Overwinter Survival

We were able to estimate the number of yearlings per 100 adult females for 6 years. Thus we were able to estimate overwinter survival of calves for: 1991-92, 1992-93, 1993-94, 1995-96, 1996-97, and 1997-98 (Table 3). Overwinter survival ranged from a high during 1993-94 of 86% to a low during 1991-92 of 23%. In 4 of the 6 years overwinter survival was >50%. Those exceptional years with low overwinter survival of calves were 1991-92 and 1996-97.

DISCUSSION

Types of Classification Surveys

We acknowledge that with multi-day ground-based classification surveys there exists a potential for double counting caribou. However, when groups were located a precise location was determined by the use of a global positioning system (GPS), and we believe that the number of double counted individuals is low and has little if any affect on the ratio calculations. Local hunters provide locations of observed caribou on 1:250,000 maps so that the probability of double counted groups can be assessed. We determined that two groups of mixed sex and age caribou (numbering 5 and 6 in total) were likely observed and reported by two different hunters. One group of 2 male caribou was seen and reported twice by the same hunters. These 3 groups were only included once in our analysis.

Calf Production

The population of non-calf Peary caribou on Banks Island was estimated to be 6,970 in 1982, 4,931 in 1985, 4,251 in 1987, 2,641 in 1989, and 897 in 1991 (Nagy *et al.*, 1996). Prior to the establishment of a quota of 150 animals (any sex) in 1990, the annual subsistence harvest during the 1970's and 1980's was estimated at 300–450 animals, predominantly females, however the female proportion was dropping quickly by the late 1980's (Nagy *et al.*, 1996; J. Nagy and N. Larter, unpubl. data). It was not until after the 1991 survey to estimate population size that aerial classification surveys were initiated in order to assess productivity and overwinter survival. In retrospect, given the rate of decline in population estimates and the level of subsistence harvest, this action occurred at least 4 years too late.

Because of the lack of long-term data, especially from the 1980's when the population was much larger (*ca.* 2,500-7,000 non-calves), there is little baseline data to assess current calf production and its annual variability as determined from a small population. The comparable data that are available for Peary caribou and Svalbard reindeer show large annual fluctuations (Table 4). Tyler (1987) found that annual variation in calf percentages and ratios was correlated to annual variation in female pregnancy rates. There were distinct "good" and "bad" years for female pregnancy. Thomas (1982) found similar annual fluctuations in fecundity of Peary caribou. Large annual fluctuations in fecundity of both Peary caribou and Svalbard reindeer occurred independent of population density, suggesting that weather likely affected the rates, and severe winters in particular (Thomas, 1982; Tyler, 1987). Severe winter weather undoubtably has some effect on delaying certain cohorts from reaching a certain weight and/or size that may be necessary in order to conceive.

Classification survey data from Banks Island since 1993 indicates that calf production was significantly higher in 1995 and 1996 than in 1993 and 1994 (Fig. 2). Production continued high in 1996 and 1997, but the difference was borderline significance ($0.05<P<0.10$). Even though these data are from limited numbers of caribou (Appendix 1), when put in the context of the estimated population they represent a more substantial percentage. Whether or not these data are indicative of fluctuations in fecundity resulting from the effects bad or favourable winter weather is debatable. The 1997-98 winter was one of the mildest in recent years (N. Larter and J. Nagy, unpubl. data; R. Kuptana, pers. comm.) and calf production the following year was at a level (74.3 calves per 100 adult females) that had not been recorded since 1982 (75.6 calves per 100 adult females). 1995-96 and 1996-97 winters had both been relatively less severe than 1993-94 and 1994-95 (N. Larter and J. Nagy, unpubl. data; R. Kuptana, pers. comm.), however

there is no clear correlation with calf production. During winter 1993-94 there was severe icing on parts of the traditional caribou wintering range (Larter and Nagy, 1994), and summer 1994 calf production was the lowest recorded, 23.3 calves per 100 adult females. Sex and age structure of a small population may also have been a factor in the variability in calf production we have documented.

High harvest of predominantly females from a declining caribou population during the late 1980's likely resulted in a population skewed toward younger animals, and quite possibly predominantly males. Data on the age of harvested males from 1990-1998 indicates a harvest skewed to younger males (N. Larter and J. Nagy, unpubl. data). Such a population in the early 1990's may have had abnormally low productivity because most animals had not reached the size for sexual maturity. During the severe winter 1990-1991 an overwinter die-off of at least 60 caribou was recorded (Nagy *et al.*, 1996). During winter 1993-1994 there was severe icing on parts of the traditional caribou wintering grounds but no die-off was recorded and calves were not in poor condition during February (Larter and Nagy, 1994). The generally higher calf production from 1995 through 1998 may have resulted from a response by a population that was getting an increasingly more normal population sex and age structure (ie less skewed towards young animals) in combination with mild winters, rather than solely a response to changes in winter severity (N. Larter and J. Nagy, unpubl. data; R. Kuptana, pers. comm.). The high levels of calf production from 1998 are similar to those in 1982 and may be representative of more normal levels for Banks Island caribou.

Calf mortality occurs throughout the year and it is likely that presenting the median calf per 100 adult female ratio lumped across circannual periods may mask annual variation in calf mortality and affect the results of the analysis. For Svalbard reindeer, Tyler (1987) found that the majority of calf mortality occurred in late winter regardless of whether it was a "good" or "bad" year for female fecundity. Using

percent calves in the population post-calving (i.e., summer period) provides an alternate minimum estimate of fecundity. Because a number of population surveys have been conducted on many of the Arctic islands there is a larger historical data set on percent calves in the population. As with the ratio data there are large annual fluctuations in percent calves, both within islands (Fischer and Duncan, 1976; Tyler, 1987; J. Nagy and N. Larter, unpubl. data) and between islands (Tener, 1963; Fischer and Duncan, 1976; Miller, 1992). Percent calves during summer from this study (12.5-32.1) are similar to those found elsewhere (Table 5). Median percent calves determined from surveys in 1993 and 1994 (12.5 and 9.8, respectively) were lower than those found in subsequent years 1995-1998 (30.4, 31.4, 17.5 and 22.9, respectively)(Table 2). A finding similar to that using the median annual ratio of calves per 100 adult females data (Table 2). The percent calves determined from the 1994 population survey of Banks Island is the second lowest recorded of 7 surveys conducted between 1982 and 1994 and the 1994 best estimate of calf production was the lowest of the 10 years that best estimates could be derived (Table 3). These data all point to low fecundity in 1994.

Overwinter Survival

Our best estimates of overwinter survival of calves ranged from 23 to 86%. The lowest overwinter survival of calves occurred during the 1991-92 winter; the winter following 1990-91 when a recorded die-off of at least 60 caribou had occurred. This may be indicative of cohort differences in survival and age at first reproduction (Albon, *et al.*, 1987) resulting from the combination of previous year's unfavourable weather and female biased harvest. The highest overwinter survival occurred during winter 1993-94 when fall icing conditions were documented on a substantial proportion of the caribou winter range (Larter and

Nagy, 1994). However, a limited number of calves that were collected during November 1993 and February 1994 were deemed to be in no poorer condition than was commonly seen at this time of year by local residents of Sachs Harbour and to be of similar condition to caribou from elsewhere based upon measures of body condition indices (Larter and Nagy, 1996).

We feel that by using classifications of yearlings in surveys conducted during May and June that misclassification is minimal. There is the increased potential for misclassifying yearlings during summer. However if there is an increase in misclassification, that bias has been kept relatively constant throughout this study because the last 5 estimates of yearlings per 100 adult females and percent yearlings were based upon classifications by the same individual (NL). Data on overwinter survival of calves are lacking. Only Tener (1963) has previously reported data on yearlings. He found percent yearlings ranging from 0.0-8.1 (median 4.3) for Peary caribou on the Queen Elizabeth Islands in 1961. The median percent yearlings was approximately one-fifth of the median percent calves reported for that year. Assuming similar productivity in 1961 and no major loss of adults an overwinter survival of 20% could have occurred, but these assumptions may well be invalid. His estimate is lower than all of ours. Our estimates could be deemed high because population data indicate a decrease in non-calf caribou on Banks Island from 709 to 425 from 1994 to 1998. During this same period calf production has been high and the reported subsistence harvest has been less than the annual quota that has been allocated. However, wolf predation of females and young animals in the calving grounds during summer and the fall migration from the north to the south, has the potential to decrease the caribou population even in the face of the high overwinter calf survival estimates we report.

Other studies on caribou and reindeer populations have shown that calf mortality is one of the main

factors affecting population growth (Bergerud, 1971; Parker, 1972; Skogland, 1985; Tyler, 1987). A more accurate estimate of overwinter survival could be determined by following radio-collared females to determine their calf production and survival. However, the potential for this method on Banks Island will be constrained by small sample size, the likelihood of large annual variation, the cost of deployment, and the costs and logistical problems associated with getting visual observations of these animals during high Arctic winters. Nonetheless, accurate estimates of overwinter survival remain a key population parameter that continues to prove extremely elusive.

RECOMMENDATIONS

1) Early July classification surveys cannot detect neonatal losses, but likely provide the best estimate of calf productivity. Although May-June classification surveys likely provide the lowest potential for misclassifying yearlings, early July surveys likely provide adequate data. Therefore since the costs involved will limit classification surveys to one per year it should be conducted in early July so that we can get the best estimate of calf productivity and of overwinter survival of calves using survey methodology.

2) Estimates of overwinter survival of calves is more affected by reduced sample size than estimates of calf production. It is essential that classification surveys strive to get the largest sample sizes possible. Therefore, a fixed-wing reconnaissance flight to determine localized caribou concentrations should be conducted whenever possible prior to the helicopter being dispatched to classify caribou.

3) Large annual variation in survival, limited sample sizes, and the costs associated with deploying and tracking precludes the use of conventional radio-collars on animals on Banks Island unless satellite radio-collars are also deployed. The high cost of a satellite radio-collaring program may limit its feasibility, however it has the potential to provide accurate estimates of calf production and overwinter survival of calves.

4) Annual aerial classification surveys must be continued even though they are no longer associated with and subsidized by range study field work.

5) Continue to collect classification data from all caribou observed during all field work conducted on Banks Island.

6) Continue to encourage local residents and workers for other agencies to provide DRWED with caribou numbers, locations, and classifications whenever possible. And report any findings of dead animals.

7) Continue to work with other biologists to investigate other means to best estimate calf productivity and subsequent overwinter survival.

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PERSONAL COMMUNICATIONS

Andy Carpenter, Sachs Harbour resident hunter and trapper.

John Lucas Sr., Sachs Harbour resident hunter and trapper.

Roger Kuptana, Sachs Harbour resident hunter and trapper.

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Figure 1. Traditional critical Peary caribou wintering, summering, and fall ranges (based upon Urquhart, 1973).

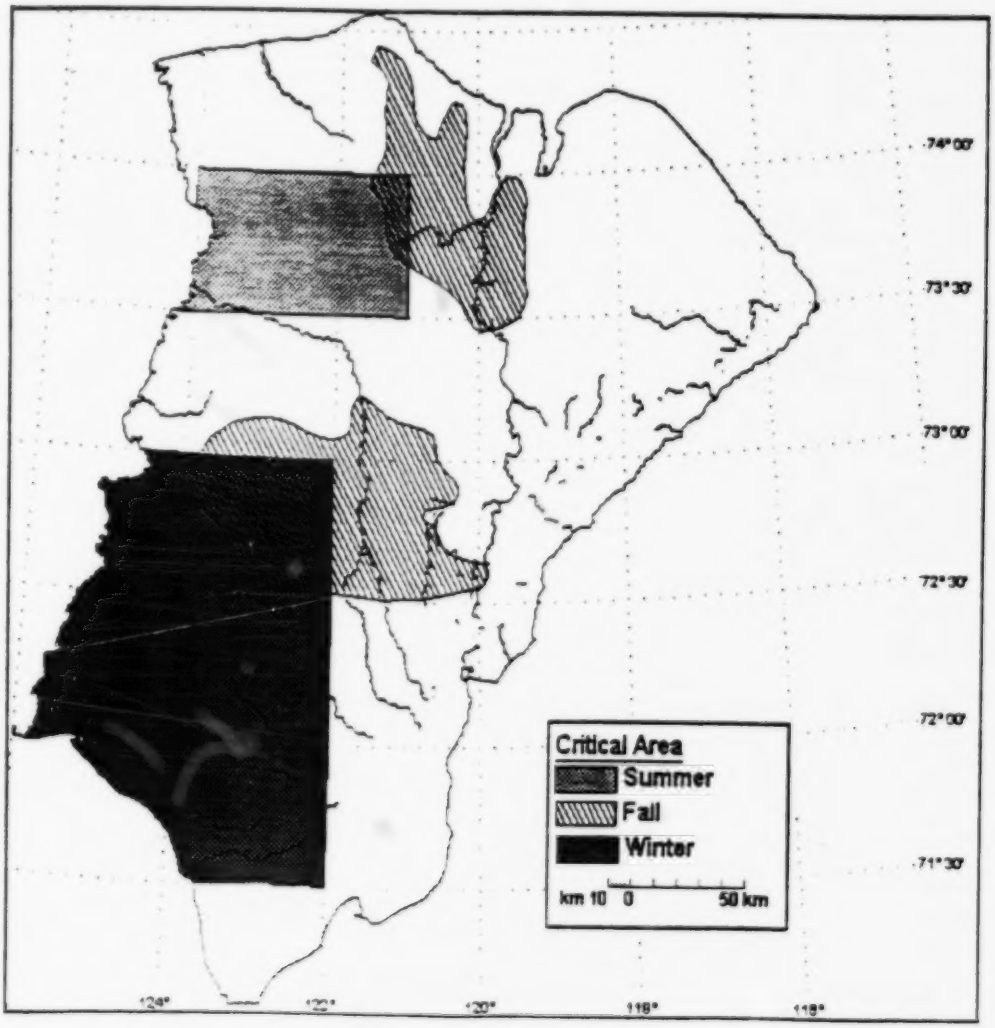

Figure 2. The ratios of calves per 100 adult females from all classification surveys during each circannual period from 1982 to 1998 on Banks Island. See text for time of year used to define each circannual period.

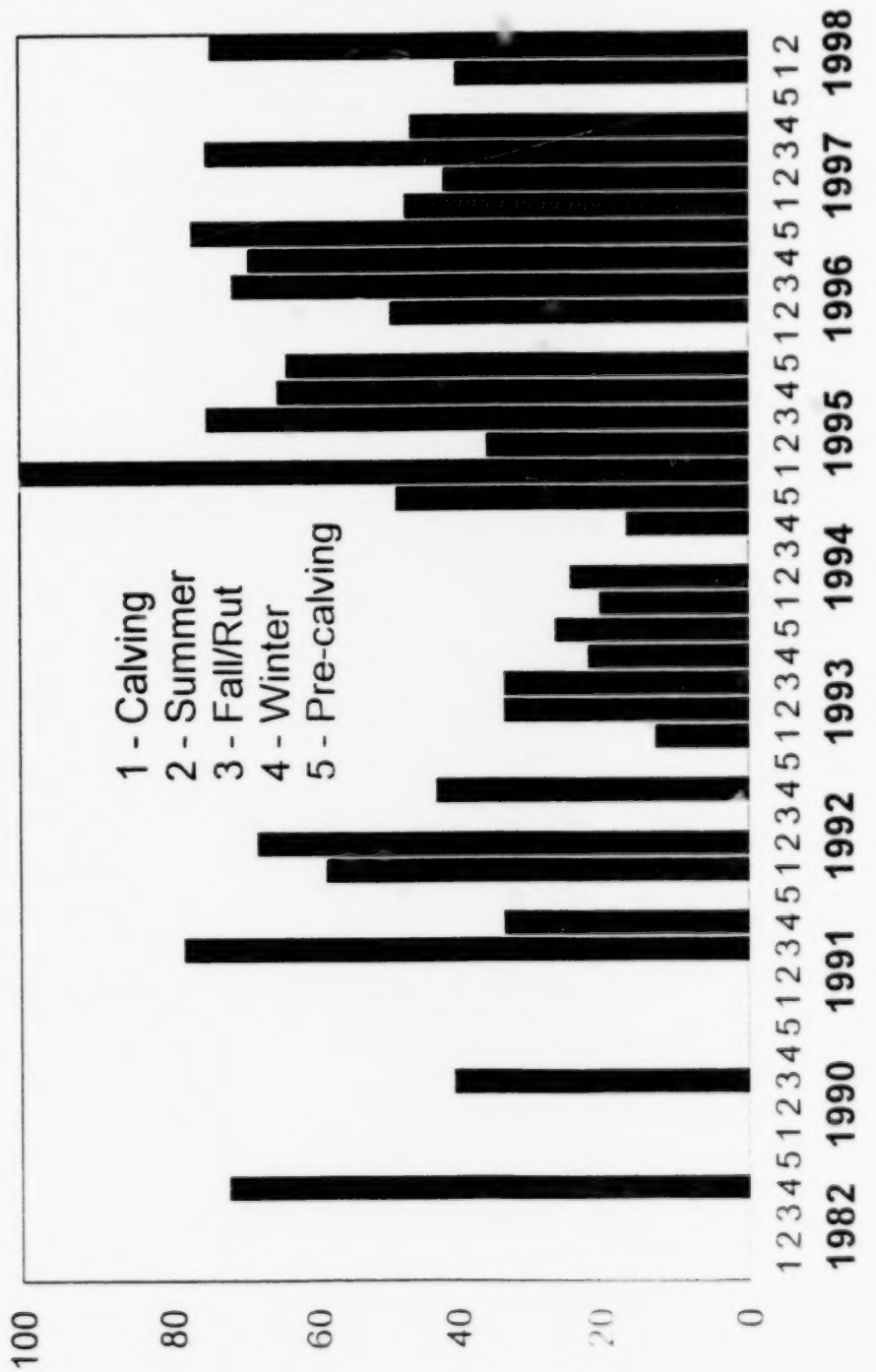

Table 1. The dates of classification surveys, number of animals classified, and method of classification for surveys conducted prior to summer 1993. The values in parentheses represent the number of unclassified adults.

Date	Number Animals Classified	Method (Ground/Air)
November, 1982	113 (4)	Ground
November, 1983	161[1]	Ground
October, 1990	104 (33)	Ground
September, 1991	38 (12)	Ground
November, 1991	33	Ground
June, 1992	60	Air
August, 1992	191	Air
March, 1993	18	Ground
May, 1993	35	Air
June, 1993	79	Air

[1] Raw data unavailable, 48 groups of unknown classification totalling 161 animals.

Table 2. The median ratios of the number of calves per 100 adult females (ca:100fem), and percent calves in the survey sample for all 10 years when surveys were conducted on Banks Island. n = the number of circannual periods in which classification surveys were conducted in that year, out of a possible 5. N = the total number of animals classified.

Year	1982	1990	1991	1992	1993	1994	1995	1996	1997	1998
n	1	1	2	3	5	4	5	4	4	2
N	113	104	71	269	346	176	144	166	238	184
ca:100fem	72.3	40.4	55.8	58.6	26.2	22.0	65.4	70.3	46.8	57.2
% calves	27.4	19.2	18.2	28.3	12.5	9.8	30.4	31.4	17.5	22.9

Table 3. Classification data that were used to best estimate the overwinter survival (%) of Peary caribou calves on Banks Island from 1991 to 1998: the survey month(s) classification data were collected, the actual number of calves, yearlings (yrlngs) and 2+ year old females classified and their accompanying ratios/100 2+ year old females, and the best estimate of overwinter survival.

	Calves			Yearlings Following Year			
Year	Survey Month	# calves/ # 2+year females	calves/100 2+year females	Survey Month	# yrlngs/ # 2+year females	yrlngs/100 2+year females	Overwinter Survival (%)
1990-1	Oct 91	20/38	52.6				
1991-2	Sep-Nov 91	13/22	59.1	Jun 92	4/29	13.8	23
1992-3	Aug 92	58/85	68.2	May-Jun 93	20/47	42.6	62
1993-4	Oct-Nov 93	18/43	41.9	Jul 94	9/25	36.0	86
1994-5	Jul-Aug 94	7/30	23.3				
1995-6	Jul-Aug 95	8/15	53.3	Jul 96	4/12	33.3	62
1996-7	Jul 96	8/12	66.7	Jul 97	4/15	26.7	40
1997-8	Jul-Aug 97	10/23	43.5	Jul 98	16/70	22.9	53
1998-9	Jul 98	52/70	74.3				

Table 4. Comparative ratios of calves per 100 adult females determined from summer (July and August) classification surveys of Peary caribou and Svalbard reindeer.

Population/Location	Year(s)	Ratio	Reference
Svalbard reindeer	1979-84	9.0-73.3	Tyler, 1987
Bathurst Is. Archipelago caribou	1990	44.4-88.2	Miller, 1992
Banks Island caribou	1990-98	33.3-74.3	This study
Melville Island caribou	1998	80.0	N. Larter & J. Nagy, unpubl. data

Table 5. Comparative percent calves determined from summer (July and August) classification surveys in populations of Peary caribou and Svalbard reindeer.

Population/Location	Year(s)	% Calves	Reference
Svalbard reindeer	1979-84	3.7-27.3	Tyler, 1987
Banks Island caribou	1990-98	12.5-32.1	This study
Banks Island caribou	1994	7.5	Nagy and Larter, unpubl.data
Banks Island caribou	1992	30.0	Nagy and Larter, unpubl.data
Banks Island caribou	1991	5.4	Fraser *et al.*, 1992
Banks Island caribou	1989	25.5	McLean and Fraser, 1991
Banks Island caribou	1987	22.6	McLean, 1991
Banks Island caribou	1985	16.6	McLean *et al.*, 1986
Banks Island caribou	1982	25.0	Latour, 1985
Banks Island caribou	1971-72	17.3-27.9	Urquhart, 1973
North Banks Island caribou	1970	19.1	Kevan, 1974
Melville Island caribou	1998	26.0	N. Larter and J. Nagy, unpubl. data
Bathurst Is. Archipelago caribou	1990	15.7-19.6	Miller, 1992
Parry Islands caribou	1975	17.0-35.0	Fischer and Duncan, 1976
Parry Islands caribou	1974	0.0-28.0	Fischer and Duncan, 1976
Queen Elizabeth Is. caribou	1961	10.8-29.7	Tener, 1963

APPENDIX

Appendix 1. The ratios of calves (Ca) and yearlings (Yr) per 100 adult females (Cow), the percent calves and yearlings, the number of groups, animals, and known males classified during different life cycle periods for 1982, and 1990 to 1998. A range in ratios is given where unknown adults were part of the classification. The midrange was used for the statistical analyses.

Period	Ca:100 Cow	Yr:100 Cow	% Ca	% Yr	# grps	# anim	# male
Winter 1982-83	68.9-75.6	26.7-29.3	27.4	10.6	28	113	25
Rut 1990	28.2-52.6	2.8-5.3	19.2	1.9	15	104	11
Rut 1991	42.1-114.3	10.5-28.6	21.1	5.3	8	38	9
Winter 1991-92	33.3	0.0	15.2	0.0	8	33	13
Calving 1992	58.6	13.8	28.3	6.7	21	60	10
Summer 1992	68.2	1.2	30.4	0.5	54	191	47
Winter 1992-93	42.9	0.0	16.7	0.0	7	18	8
Calving 1993	11.7-13.2	36.7-41.5	6.1	19.3	44	114	25
Summer 1993	33.3	0.0	12.5	0.0	5	16	8
Rut 1993	33.3	8.3	20.0	5.0	15	60	9
Winter 1993-94	21.1-22.1	22.5-23.5	10.8	11.5	58	139	37
Pre-Calving '94	25.0-27.3	16.7-18.2	17.6	11.8	4	17	0
Calving 1994	20.0	120.0	4.3	26.1	7	23	11
Summer 1994	24.0	36.0	12.8	19.1	9	47	7
Winter 1994-95	8.6-24.0	7.1-20.0	6.8	5.7	23	88	7
Pre-Calving '95	40.0-57.1	0.0	22.2	0.0	7	18	3
Calving 1995	100.0	0.0	50.0	0.0	1	2	0
Summer 1995	24.2-47.1	12.1-23.5	15.4	7.7	13	52	7
Rut 1995	75.0	0.0	14.3	0.0	5	21	4
Winter 1995-96	62.5-68.2	4.2-4.5	32.6	2.2	9	46	8
Pre-Calving '96	58.3-70.0	0.0	30.4	0.0	4	23	4
Summer 1996	32.0-66.7	16.0-33.3	17.0	8.5	14	47	13
Rut 1996	71.4	0.0	34.5	0.0	7	29	5

Period	Ca:100 Cow	Yr:100 Cow	% Ca	% Yr	# grps	# anim	# male
Winter 1996-97	69.2	23.1	30.5	10.2	19	59	9
Pre-Calving '97	76.9	15.4	32.3	6.5	8	31	6
Calving 1997	44.4-50.0	16.7-18.8	21.6	8.1	11	37	8
Summer 1997	40.0-43.5	16.0-17.4	13.3	5.3	18	75	33
Rut 1997	75.0	0.0	33.3	0.0	2	9	2
Winter 1997-98	25.0-67.9	10.5-28.6	16.2	6.8	32	117	15
Calving 1998	30.0-50.0	20.0-33.3	13.6	9.1	10	22	7
Summer 1998	74.3	22.9	32.1	9.9	29	162	18